

# THE IMPACT OF 3D MODELING IN SURGICAL PLANNING AND OUTCOMES OF PARTIAL NEPHRECTOMY

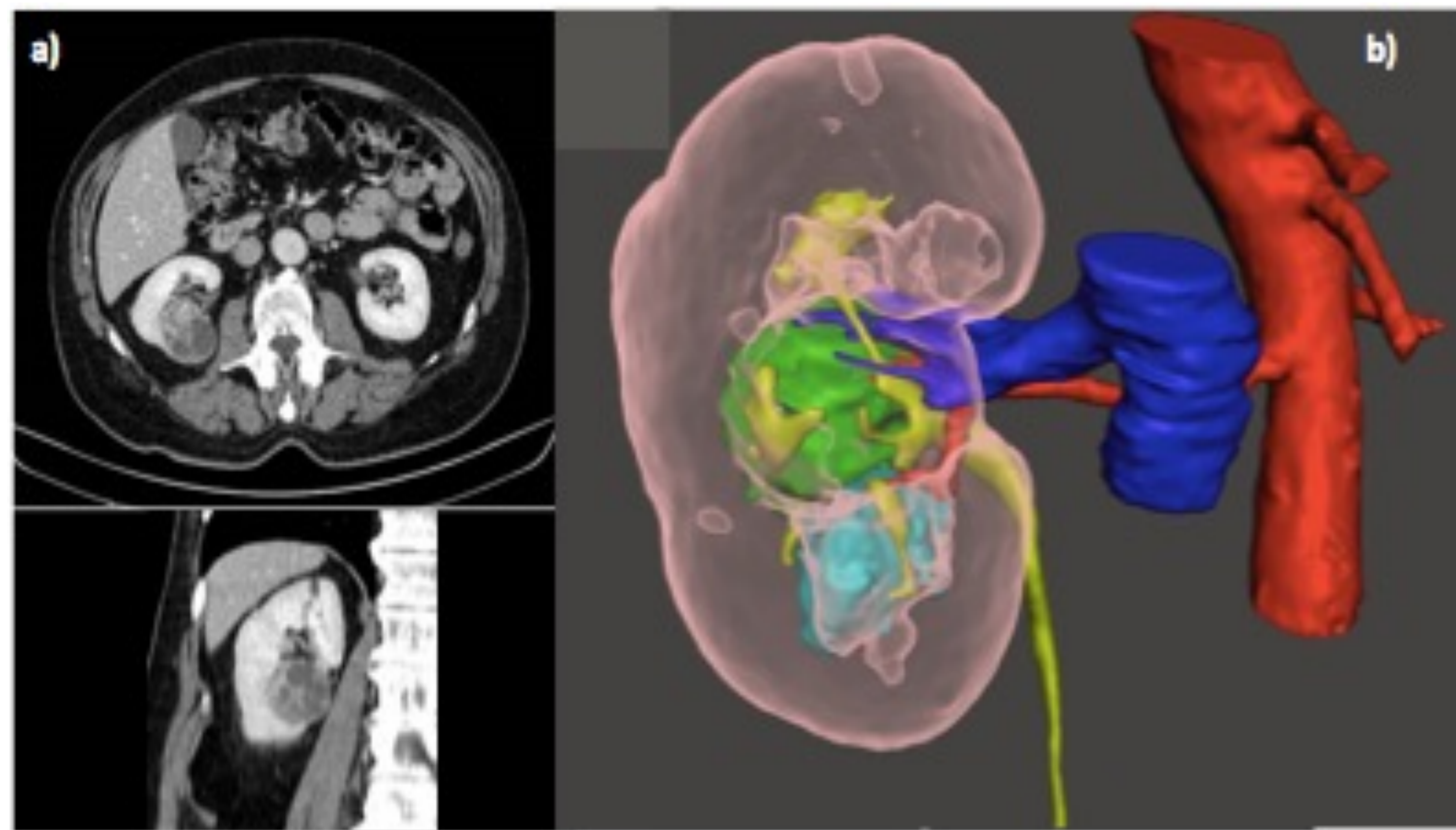
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## Introduction & objectives

- **Partial nephrectomy (PN)** is increasingly adopted as preferred treatment for **T1** and **T2 renal masses**.
- The risk of unsuccessful PN with **conversion to radical nephrectomy (RN)** is **higher in challenging cases**.
- Nowadays, **3D models facilitate** the understanding of renal anatomy and are **more accurate to assess surgical complexity** of renal masses compared to 2D imaging.
- The objective is **to evaluate the impact of 3D digital reconstructions** of renal models on **surgical planning** and **surgical outcomes** of patients scheduled for PN compared to conventional 2D imaging.

**Figure 1.** After revision of 3D model the planning of surgery was converted to RN before surgery, due to suspicious invasion of urinary collecting system and renal sinus.



**Table 2.** Sub-analysis in patients underwent PN (n= 175) to compare the preoperative planning and the intraoperative approach to the renal hilum

	Overall	Control Group (2D imaging)	Study Group (3D model)	P value
<b>Preoperative planning of arterial clamping, n (%)</b>				
Clampless	53 (30.3)	31 (36.9)	22 (24.2)	< 0.001
Main artery	68 (38.9)	46 (54.8)	22 (24.2)	
Selective or Super selective	54 (30.9)	7 (8.3)	47 (51.6)	
<b>Effective Intraoperative arterial clamping, n (%)</b>				
Clampless	57 (32.6)	31 (36.9)	26 (28.6)	< 0.001
Main artery	77 (44)	45 (53.6)	32 (35.2)	
Selective or Super selective	41 (23.4)	8 (9.5)	33 (36.3)	

	Overall	Control Group (2D imaging)	Study Group (3D model)	P value
<b>Effective Intraoperative Clamping approach as previously planned, n (%)</b>				
Clampless	37 (69.8)	23 (74.2)	14 (63.6)	0.05
Main artery	55 (80.9)	35 (76.1)	20 (90.1)	0.005
Selective or Super selective	31 (57.4)	2 (28.6)	29 (61.7)	<0.001

**Table 3.** Intraoperative, peri-operative, pathologic and postoperative characteristics in the overall population underwent PN (n=175)

	Overall	Control Group (2D imaging)	Study Group (3D model)	P value
<b>Post-operative complications grade, n (%)</b>				
Overall	34 (19.4)	17 (20.2)	17 (18.7)	0.8
-Clavien 1-2	24 (13.7)	13 (15.5)	11 (12.1)	
-Clavien 3	10 (5.7)	4 (4.8)	6 (6.6)	
<b>Positive Surgical Margins, n (%)</b>	11 (6.3)	7 (8.3)	4 (4.4)	0.3
<b>≤30% postoperative eGFR reduction from baseline at discharge, n (%)</b>	141 (80.6)	62 (73.4)	79 (80.6)	0.03
<b>Trifecta achievement, n (%)</b>	126 (72)	53 (63.1)	73 (80.2)	0.01

## Patients & methods

- **195 patients** with **cT1-T2** renal cancer eligible for PN were **prospectively** enrolled.
- Two groups: **study group (n=100 patients, 51%)**, with a **3D renal model** obtained before surgery; **control group (n=95 patients, 49%)** with only **2D imaging** of CT before intervention.
- **Impact of 3D models** in the **preoperative planning of PN** evaluating **rate of conversion to RN** and type of **arterial clamping**
- **Impact of 3D virtual model** to achieve the **Trifecta** for PN (defined as the contemporary **absence of PSM, major complications** and **≤30% postoperative eGFR reduction**).
- **Multivariate logistic regressions** were used to identify **predictors** of **selective clamping** and **Trifecta's achievement** in patients treated with PN (n=175)

## Results

**Table 1.** Patient characteristics and descriptive statistics in the overall population (n=195)

	Overall	Control Group (2D imaging)	Study Group (3D model)	P value
<b>No. of patients, n (%)</b>	195	95	100	
<b>Clinical stage, n (%)</b>				
cT1a	144 (73.8)	69 (72.6)	75 (75)	0.9
cT1b	46 (23.6)	23 (24.2)	23 (23)	
cT2a	5 (2.6)	3 (3.2)	2 (2)	
<b>PADUA risk, n (%)</b>				
Low	63 (32.3)	30 (31.6)	33 (33)	0.9
Intermediate	79 (40.5)	39 (41.1)	40 (40)	
High	53 (27.2)	26 (27.4)	27 (27)	
<b>RENAL risk, n (%)</b>				
Low	71 (36.4)	33 (34.7)	38 (38)	0.9
Intermediate	99 (50.8)	50 (52.6)	49 (49)	
High	25 (12.8)	12 (12.6)	13 (13)	
<b>Clinical lesion diameter at CT scan (cm)</b>				
Median (IQR)	3.1 (2.2-4)	3.2 (2.2-4.2)	3 (2.2-4)	0.9
<b>Surgical technique, n (%)</b>				
Open	37 (19)	20 (21.1)	17 (17)	0.2
Laparoscopic	25 (12.8)	16 (16.8)	9 (9)	
Robotic	133 (68.2)	59 (62.1)	74 (74)	
<b>Conversion to RN n (%)</b>	20 (10.3)	11 (11.6)	9 (9)	0.6
<b>Conversion to RN*, n (%)</b>				
Pre-planned (before surgery)	10 (50)	3 (27.3)	7 (77.8)	0.03
Not planned (during surgery)	10 (50)	8 (72.7)	2 (22.2)	

**Table 4.** Multivariate logistic regression analyses to predict the adoption of selective or super-selective clamping and the achievement of Trifecta in patients underwent PN (175).

	ADOPTION OF SELECTIVE OR SUPER-SELECTIVE CLAMPING				ACHIEVEMENT OF TRIFECTA			
	MODEL 1		MODEL 2		MODEL 1		MODEL 2	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
<b>Age at surgery (years)</b>	-	-	-	-	0.99 (0.95-1.02)	0.8	0.98 (0.95-1.02)	0.9
<b>ASA score</b>								
1-2	-	-	-	-	1.0 (Ref)	0.3	1.0 (Ref)	0.4
≥3	-	-	-	-	1.51 (0.64-3.72)		1.47 (0.62-3.50)	
<b>PADUA score</b>	1.19 (0.94-1.49)	0.1	-	-	0.86 (0.70-1.07)	0.2	-	-
<b>RENAL score</b>	-	-	1.07 (0.86-1.32)	0.6	-	-	0.86 (0.71-1.04)	0.1
<b>3D virtual model</b>								
No	1.0 (Ref)	<0.001	1.0 (Ref)	<0.001	1.0 (Ref)	0.01	1.0 (Ref)	0.02
Yes	5.26 (2.22-12.50)		5.04 (2.14-11.88)		2.42 (1.19-4.92)		2.41 (1.18-4.90)	
<b>Surgical approach</b>								
Open	1.0 (Ref)	0.2	1.0 (Ref)	0.2	1.0 (Ref)	0.7	1.0 (Ref)	0.4
Laparoscopic	0.33 (0.03-3.31)	0.3	0.28 (0.03-2.83)	0.3	0.59 (0.15-2.35)	0.5	0.59 (0.15-2.32)	0.7
Robot assisted	1.68 (0.55-5.14)	0.4	1.60 (0.53-4.86)	0.4	0.85 (0.28-2.49)	0.8	0.83 (0.28-2.43)	0.1

## Conclusions

- The adoption of **3D model for preoperative surgical planning of PN** allows to **reduce the rate of intraoperative not-planned conversion to RN** due to **better comprehension of tumor's anatomy** compared to conventional 2D imaging.
- When PN is performed, the use of **3D model** allows to **increase the adoption of selective and super-selective arterial clamping** and to **achieve higher rate of trifecta**, increasing the precision of surgery.

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